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00Y-TR-63-20 **JUNE 1963** 8 AIRMUNITIONS TEST REPORT SERVICE AND SHELF LIFE OF EXPLOSIVE SWITCH P/N 1186 FOR T3019E5 ARMING PROGRAMMER IM99A MISSILE 77050 ATRABASIADAS WIND OGDEN GEOGRAPH WATCHELAREA BREET CARL AR COCC - NEEL AG MEET BACK, MAI

SERVICE AND SHELF LIFE OF

EXPLOSIVE SWITCH P/N 1186 FOR

T3019E5 ARMING PROGRAMMER

IM99A MISSILE

bу

Don F. Woods

PUBLICATION REVIEW

This report has been reviewed and is approved

ALEX D. PERESICH Chief, Engineering and Test Division 2705th Airmunitions Wing

JUNE 1963

2705TH AIRMUNITIONS WING OGDEN AIR MATERIEL AREA AIR FORCE LOGISTICS COMMAND UNITED STATES AIR FORCE Hill Air Force Base, Utah

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The conclusions and recommendations made in this report are not to be considered directive in nature. This type information becomes official only when published in Technical Orders or other applicable Air Force publications.

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ADMINISTRATIVE DATA

PURPOSE OF TEST:

The purpose of this test was to determine if the service life of Explosive Valve, P/N 1186 for T3019E5 Arming Programmer could be extended.

MANUFACTURER:

Raymond Engineering Laboratories, Inc., Middletown, Connecticut

ITEM IDENTIFICATION:

Federal Stock Number 1336-794-8729

Part Number 1186

Nomenclature, Explosive Switch

Module P/N 10406468

QUANTITY OF ITEMS TESTED:

58 Explosive Switches (29 switch modules)

22 Hot (120°F) 26 Cold (-40°F)

SECURITY CLASSIFICATION:

Unclassified

DATE TESTED:

April 1963

TEST CONDUCTED BY:

OOAMA (OOYET - 2705th Airmunitions Wing)

Test Director: Richard O. Miller, Captain, USAF Project Officer: Don F. Woods, Mechanical Engineer

Test Directive: M-3-822-Y

00Y-TR-63-20

DISPOSITION OF SPECIMENS:

All metal components, generated from this test were inspected and certified inert in accordance with Technical Order 11C3-1-3. These components were then turned over to the Redistribution and Marketing Division.

C.

INTRODUCTION

The REL 1186 Explosive Switch is used in the T3019E5 Arming Programmer and is part of the IM99A (Bomare) Weapon System. The purpose of the switch is to break and make two electrical circuits during the flight of the missile.

Currently the explosive switch has a three year service life. The arming programmers are normally cycled through the OOAMA maintenance facility every 16 months. Therefore, two cycles (32 months) is the maximum time that the switches can be used. Testing was accomplished to determine if the service life of the explosive switch could be increased so that the switches could be used for three cycles (48 months) or possibly four cycles.

The tests were conducted under Test Directive M-3-822-Y prepared by the Ground Launch Missile Branch, 2705th Airmunitions Wing.

DESCRIPTION

The REL 1186 Explosive Switch is a two circuit transfer device actuated by electric ignition of a small amount of lead styphnate. The gas produced from the explosive causes a metal disk shorting two contacts (normally elosed circuit) to be forced off from these contacts and across two other contacts (normally open contacts), causing one circuit to open and one circuit to close. The switch does not rupture upon activation. The external appearance is unchanged.

The switch is about 0.56 inch long and 3.8 inches in diameter. The sheath is a brass cylinder. Four leads, from the electrical contacts, extend from one end. The leads from the explosive bridge wire, extend from the other end. The switch is sealed with potting compound.

Two switches (for redundancy) are used in each arming programmer. The two switches and a connecting plug are potted together forming a switch module (Figures 1A and 1B). The internal wiring of the module is shown in Figure 2.

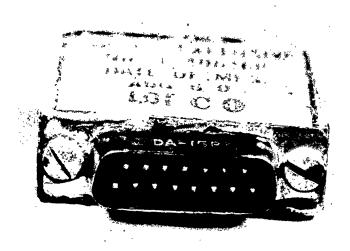
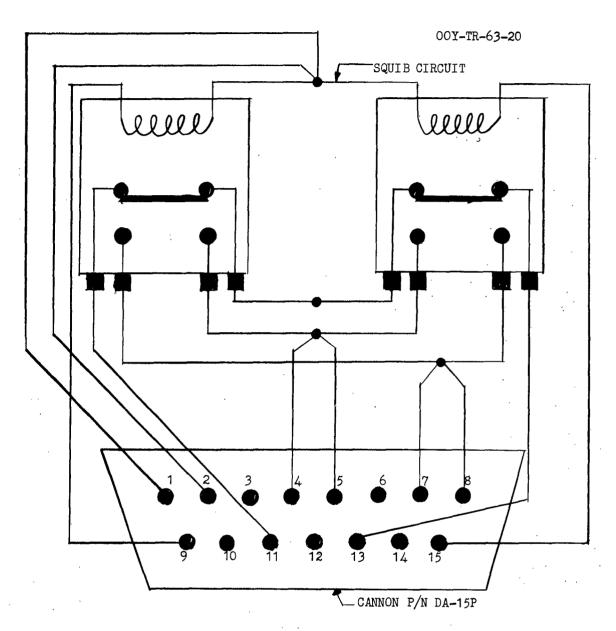


FIGURE 1A. Explosive Switch Module.



FIGURE 1B. Explosive Switch Module.



63

FIGURE 2. Internal Electrical Schematic of Switch Module

00Y-TR-63-20

TEST SAMPLES

The test samples were obtained from arming programmers during their maintenance recycle. Twelve samples were manufactured in March 1960. These items were from lot CM. The remaining 46 switches were manufactured in January 1960. The lot designator for these switches is unknown.

TEST PROCEDURES

TEMPERATURE CONDITIONING

Eleven switch modules were conditioned at 120°F and 18 switch modules were conditioned at -40°F for 24 hours before testing.

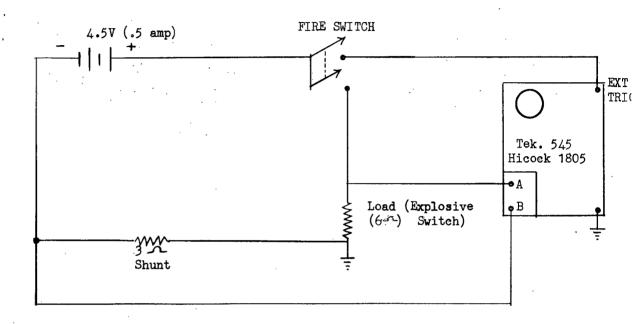
PRE-FUNCTIONING INSPECTION

Prior to functioning, the electrical circuits were checked for resistance and continuity as follows (refer to Figure 2):

- 1. Pins 1 and 9, and 1 and 15 were checked for continuity using an ohmmeter.
- 2. Pins 11 and 13 were checked for continuity using an ohmmeter.
- 3. Pins 4 and 7 were checked for electrical insulation resistance using a 500 volt insulation test set.

STATIC FUNCTIONING

Each of the two switches inside a module were tested independently by applying a firing current to pins 1 and 9 and then pins 1 and 15 (Figure 2). The switches were fired using an electrical arrangement and oscilloscope as shown in Figures 3 and 4. The firing pulse across the face of the oscilloscope was photographed. In this manner firing current, firing voltage and ignition delay were obtained for each switch. The energy required for firing trace.



'A' input

1.5V C/M

polarity - "Inverted"

Zero Reference - Top line

'B' input
.5V C/M

polarity - "Inverted"

Zero Reference - Bottom line

Trigger = "+ Ext"

Mode = "DC"

Sweep = "200 u sec C/M"

Magnifier - "Off"

Main Sweep - "Normal"

FIGURE 3. Static Firing Schematic Electrical Hook-up.

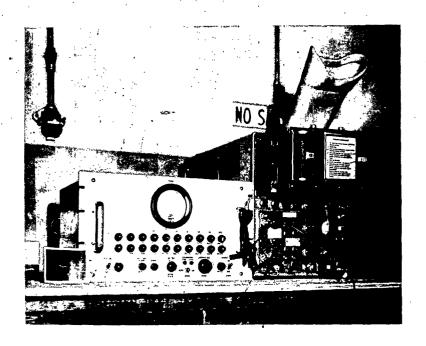


FIGURE 4. Test Set-Up.

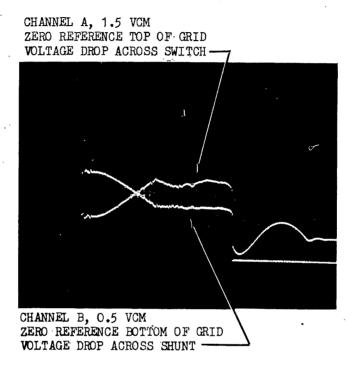


FIGURE 5. Typical Firing Trace - 40°F.

00Y-TR-63-20

POST FUNCTIONING INSPECTION

After firing electrical circuits 1 and 9, 1 and 15, and 11 and 13 were checked for the expected open condition using a 500 volt electrical insulation checker. Circuit 4 and 7 was checked for continuity with an ohmmeter.

All switches modules were radiographed to verify that both switches inside the module functioned. This could not be determined electrically because of the parallel hook-up of the two normally open contacts and the series hook-up of the normally closed contacts inside the module (Figure 2).

TEST RESULTS

PRE-FIRING INSPECTION

The resistance of both squib circuits (pins 1 and 9, and 1 and 15 were within specification $(6 \pm 2 \text{ ohm})$ for all switch modules. Circuits 11 and 13 were closed (resistance below the capacity of the instrument to record). The normally open circuit (pins 4 and 7) had a resistance greater than the range of the 500 volt insulation tester (1000 megohm). Table 1 contains tabulated test results.

STATIC FUNCTIONING

A fire pulse was observed for each switch indicating that the bridge wire had broken. Most fire pulses were recorded by camera. A few pulses were not recorded due to equipment failure. All traces obtained were similar in appearance (Figure 5). Table 1 contains a tabulated record of the firing voltage, firing current, ignition delay and energy input level for each switch.

POST FIRING INSPECTION

Electrical check of the switch module revealed that:

- 1. The bridge circuit (pins 1-9 and 1-15) were open (normal).
 - 2. Circuit 4-7 was closed (normal).
 - 3. Circuit 11-13 was open (normal).

				,				
		·	TIME TO					
			OPEN	ENERGY	BRIDGE			
SWITCH	FIRING	FIRING	IGNITION	1	RESIST-		FIRING	
NUMBER	VOLTAGE		BRIDGE	IGNITE	ANCE	AGE	TEMP	NUMBER
	(VOLTS)	(MILLI- AMPS_	(MICRO- SECONDS)	(ERGS)	(OHM)	(MO)	(°F)	
1,1-9	1.95	300	800	4690	6.49	38	120	CM
1,1-15	2.10	300	800	5050	6.69	38	120	CM
2,1-9	2.10	3 00	800	5050	6.13	40	120	Unknown
2,1-15	1.80	3 33 " '	640	3830	4.96	40	120	Unknown
3,1-9	2.10	2 67	980	4830	7.15	40	120	Unknown
2,1-15	1.35	300	860	3480	6.06	40	120	Unknown
6,1-9	1.65	3 00	680	3370	5.64	40	120	Unknown
6,1-15	1.65	<u>33</u> 3	68Q	3740	4.20	40	120	Unknown
7 ,1- 9	2.40	3 00	760	5460	6.78	40	120	Unknown
7,1-15	1.80	317	720	4110	5.45	40	120	Unknown
9,1-9	1.95	300	840	4910	6.10	3 8	120	CM
9,1-15	1.50	333	750	3750	5.16	38	120	CM
10,1-9	2.08	283	980	5760	6.45	40	120	Unknown
10,1-15	NOT	OBTAINE)		5.91	40	120	Unknown
11,1-9	2.25	3 00	1080	7300	6.88	40	120	Unknown
11,1-15	1.50	3 50	720	3780	5.33	40	120	Unknown
13,1-9	2.10	311	1280	8360	5.80	38	120	CM
13,1-15	1.95	300	680	3980	6.27	38	120	CM
15,1-9	1.65	317	740	3870	5.52	40	120	Unknown
15,1-15	1.95	317	800	4950	5.91	40	120	Unknown
17,1-9	2.25	3 00	800	5400	6.32	40	120	Unknown
17,1-15		OBTAINE		<u> </u>	5.85	40	120	Unknown
19.1-9	1.8	317	860	4900	6.14	40	- 40	Unknown
19,1-15	TON	OBTAINE			6.66	40	- 40	Unknown
20,1-9	1.95	317	720	4450	5.53	· 40	-40	Unknown
20,1-15	1.65	317	1080	5650	6.68	40	-40	Unknown
21,1-9*	1.95	317	760	4700	5.06	40	- 40	Unknown
21,1-15	2.40	266	960	6130	8.28	40	-40	Unknown
22,1-9	2.40	317	760	5790	6.64	38	-40	CM
22,1-15	1.80	350	760	4790	4.99	38	- 40	CM
23,1-9	1.80	3 00	720	3880	4.70	40	- 40	Unknown
23,1-15	2.70	266	1000	7190	6.74	40	-40	Unknown
25,1-9	1.95	300	820	4800	6.09	40	- 40	Unknown
$\frac{25,1-15}{25}$	2.55	300	580	4440	6.80	40	-40	Unknown
~/9101/	~ 0 / /	700	700	4440	0.00	440	40	. CHAILOWII

TABLE 1. Test Data Sheet. (Continued on next page.)

^{*}Switch malfunctioned.

			m=1.673 m0				 	
			TIME TO	DMDDAX	חדומים			
SWITCH	FIRING	FIRING	OPEN IGNITION	ENERGY TO	BRIDGE RESIST-		FIRING	LOT
NUMBER	VOLTAGE	1	BRIDGE	IGNITE	ANCE	AGE	TEMP	NUMBER
NUMBER	VOLIAGE	(MILLI-	(MICRO-	TONTIE	ANCE	AGE	T TAVIT	NUMBER
	(VOLTS)	AMPS	SECONDS)	(ERGS)	(OHM)	(MO)	(°F)	
26,1-9	2.10	317	920	6130	7.73	40	-4 0	Unknown
26,1-15	2.10	317	920	6130	6.57	40	- 40	Unknown
27,1-9	2.10	283	840	5000	5.84	38	- 40	CM
27,1-15*	2.70	251	1100	7450	7.62	: 38	- 40	CM
28,1-9	0.9	317	720	2060	5.19	· 38	- 40	CM
28,1-15	1.05	350	920	3380	5.52	38	- 40	CM
29,1-9	1.65	333	680	3740	5.30	40	- 40	Unknown
29,1-15	2.10	300	880	5 550 ·	6.43	40	-40	Unknown
30,1-9	1.80	333	680	4090	5.01	40	-40	Unknown
30,1-15	1.20	333	760	3040	5.43	40	- 40	Unknown
31,1-9	1.50	317	960	4560	5.59	40	-40	Unknown
31,1-15	2.55	2 50	740	4730	5.81	40	- 40	Unknown
32,1-9	1.50	333	940	4700	5.84	40	- 40	Unknown
32,1-15	1.65	333	820	4500	5.84	40	- 40	Unknown
33,1-9	2.25	300	920	6220	6.61	40	- 40	Unknown
33,1-15	1.50	333	800	4000	5.32	40	- 40	Unknown
34,1-9	2.40	300	960	6910	6.38	40	-40	Unknown
34,1-15	2.10	300	1080	6800	7.11	40	- 40	Unknown
35,1-9	1.95	300	1000	5850	6.82	· 40	-40	Unknown
35,1-15	1.65	333	840	4620	5.79	40	-40	Unknown
37,1-9	пол	OBTAINE			4.88	40	65	Unknown
37,1-15	NOT	OBTAINE)		4.91	40	65	Unknown
38,1-9	2.10	333	600	4200 ·	4.91	40	65	Unknown
38,1-15	2.25	300	920	6220 .	6.57	40	65	Unknown

TARLE 1. (Continued from previous page) Test Data Sheet.

^{*}Switch malfunctioned.

Radiographic inspection, however revealed that one switch in each of two modules had not functioned. Figures 6A and 6B are radiographs showing the internal details of the switches. One switch was manufactured in January 1960 and one in March 1960.

Apparently the bridge wire had burned open but the explosive had not functioned. In order to determine the cause of the defects, the two faulty switches were carefully dissected by filing away switch material and inspecting the internal structure as the filing proceeded.

One switch was inspected by filing away from the side of the switch. The second switch was inspected by filing away from the top of the switch.

Filing away the switch from the side did not reveal any explosive or bridge wire. This method of inspection was not satisfactory for dissecting the switch, because such a small amount of explosive is present that it cannot be seen from the side.

The second switch was filed from the top. The potted end of the lead wires with a thin film of explosive was obtained intact (Figure 7). The explosive was scraped away between the lead wire ends revealing that the bridge wire between the lead wires was missing. A tiny portion of the explosive was removed and checked for ignitability by contact with the flame from a match. The explosive detonated with an audible report indicating that it was still sensitive to heat.

As the one sample was filed down from the top, the lead wires were visible. One lead wire was observed to have been inserted in a folded (accordian) like position. The cross section of this wire at various depths from the top of the switch toward the bridge, was not round but rectangular as would be obtained from filing the side of the wire. This folding caused the two lead wires to almost touch at several points. It is conceivable that lead wires inserted in this manner could touch each other, effectively shorting out the bridge. It is not likely that the switches malfunctioned in this way, since the resistance of the bridge circuit was normal for the two switches (5.06 ohm and 7.62 ohm). Also, the bridge wire was not found under the explosive.

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FIGURE 6A.

SHORTING Radiograph of Unfired Switch Module

NORMALLY OPEN CONTACTS NORMALLY CLOSED CONTACTS LOCATION OF EXPLOSIVE SHORTING DISK
MOVED TO
NORMALLY OPEN
CONTACTS—

WOID LEFT BY
FUNCTIONED
EXPLOSIVE

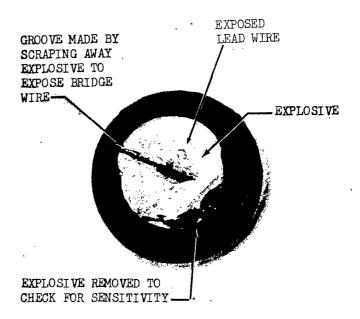
TILLS EAISOTAXE INTACT

8

SWITCH DID NOT FUNCTION

FIGUTR 6B. Radiograph of Fired Switch Module

0



MAGNIFIED APPROXIMATELY 7 TIMES

FIGURE 7. Explosive Film Intact After Switch Received Fire Pulse.

Two switches that had functioned were then dissected, for comparison. The lead wires in both of these switches extended vertically into the switch without any folding. The spacing between these wires was adequate at all times to prevent shorting.

Two possible causes for failure of the switch are:

- 1. The explosive immediately around the bridge wire was melted away from the bridge or desensitized from the application of stray voltages or test voltages less than that required for detonation.
- 2. The bridge wire and explosive were not in intimate contact at the time of manufacture.

CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the failure of the two switches was due to isolated causes and not the result of aging. This opinion is substantiated by the fact that all of the other switches tested functioned satisfactorily without evidence of degradation. If aging were the cause of the switch failures, it would be reasonable to expect its effects to show up in a fairly high percentage of samples of the same age and lot.

The ability of the REL 1186 Explosive Switch to function cannot be positively determined by non-destructive tests (electrical check-outs or by radiographs). This statement excludes obvious defects such as an open bridge circuit, missing parts, etc. Reliability must be insured by aggressive quality control during manufacture and a well designed quality assurance test program of completed articles.

The minimum (no worse than) reliability demonstrated by the switches was 89.5 per cent at a confidence limit of 95 per cent. Considering redundancy (two switches within one module). The reliability demonstrated was 98.9 per cent at a 95 per cent confidence limit.

The REL 1186 explosive switch functioned satisfactorily after 40 months in service.

It is recommended that the service life be extended to 54 months from the date of manufacture.

DISTRIBUTION LIST

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AD 2705th Airmunitions Wing (GOAMA), Hill Air Porce Rese, Utah SERVICE AND SHELF LIFE OF EXPLOSIVE SAITCH PAN 1186 FOR T2019ES APMING FORGARDERS 1993A HISSILE, by Don F. Woods, June 1963, 15p Incl. figures and tables. (GOY-TR-63-20) Unclassified Report	The RE 1186 Replosive Sattch is used in the 7301955 Awaing Programmer to break and make aleactrical circuits during the Tailght of the 11894 Bonart 148316. The current service life of the author is 36 menths. Amaing Programmers are orgical strongh the 504th Authoremore Scality about 2007 to months. The control of the author is 32 and in the use take can be obtained from a inidividual action. The purpose of this fest was to determine if the service life could be purpose of this fest was to determine if the service life could be testined to the three or sore cycles of use could be realized from the sattches. Pitty-eight samples were tested (2) modules with two statches wired in parallel for redundancy). These speciesmes vere imspected, functioned and recorded by an oscilloscope and casers arternagement. Firth copen vice principle of redundancy). These speciesmes vere inspected, functioned and recorded by an oscilloscope and casers arternagement. Firth copen vice principle current, ignition daily and the energy required too open the principle current, were achoritated. Firther statements function in the same module; therefore, all modules would have performed their intended merition. It is considered that the maintainer railability demonstrated by the actions was 89%, 5 per cent confidence level. Oncondenting the redundancy of the systom (two states and percent at 8 5) per cent confidence level. 1982 in cont. confidence level. 1982 in the redundancy of the systom (two states of the samples of the sa		2005th diramations Wing (COMMA), Mill Air Force Base, Utah SCRITCE AND SMETA LINE OF EXTROSTE SHITCH PAR 1166 FOR 19095A JANTED, FROCALSHEEN 1899A MISSILE, by Don F. Mooder, June 1969, 1979 Ind., figures (COT-1805-20) The REL 1186 Explosive Soften is used in the 1901955 Arring Programmer	Bomer and and electrical circuits and entitle to the pigot A brank and and electrical circuits and entitle to the pigot A brank and and a control action a control action and a control action action action and a control action
UNCLASSIFIED 1. Explosive Saitch I. Don F. Woods		UNCLASSI FI ED	UMCLANSIFIED 1. Explosive Switch I. Don F. Woods	
AD Z705th Airwunitions Wing (COMMA), Hill Air Force Rass, Utah SERTICE AND SHELP LIFE OF EXPLOSIVE SWITCH P/N 1166 FOR T9019988 FROURAMER HYSPA HISSILE, by Don F. Woods, June 1962, 15p incl. figures and tables. (FOURTHERS) (FOURTHERS)	The RE. 1186 Explosive Soltch is used in the T9019EX Aming Programsor to break and make a jectrical circuite during the Lingst of the 11899. However, Massia. The current service life of the switch is 36 months. Arming Programsors are opposed through the Ookid Maintenance Resility. About every 16 months. Therefore, a maximum of two opples (32 months) as all the use that can be obtained from a individual satisf. The purpose of this test was to determine if the service life could be extended so that three or now opples of use could be resilised from the satisface. Riversight samples were tested (29 months were the satisface). These species were the satisfaced, functioned and residently for redundancy). These species were thinge-clock, functioned and residently of produced the energy required to open the Parist of residently and the sample required to open the Parist out recorded by m contilocope and cases for each satisface function. It is considered function. It is considered that the satisface of the state of the result of degradation caused by sging. The minima reliability demonstrated by satisface or at all 25 per cent confidence level. Onesdering the redundancy of the sprice life of the manuface of the manuf		AD 2709th Atrauntition Wing (DOMA), Will Air Porce Bass, Utah SZNETICA, AUS SEEF ILIFE OF EXPLISION SATION PAY 1966 FOR TOTAYOS ARRUNG PROCESSAGE 1899A MISSILE, by Don P. Woods, June 1963, 199 Incl. Ilgures and tables. The REAL SEEF SEEF SEEF SEEF SEEF SEEF SEEF SEE	Bosary Marsile. The current service life of the switch is 36 months. Araling Programmers are opples through the ODMA Maintenance Pacility about every? for months. Therefore, a maximum of the orgals (2s months.) and prefore, a maximum of the orgals (2s months) is all the use that can be obtained from an individual match. The use that the use that can be obtained from an individual match. The extended so that three or more determine if the service life could be retracted so that three or more orgals of use could be retained as they extended so that three or more orgals of use could be retained as first extens. Fifty-eight samples were tested (2s modulas with two satchess aried in parallel for redundancy). These speciasons were strangement, management, and the control of the same modular than early and the energy required to open the bridge circuit were about to a Piffy-six within formal threaded function. It is considered that the mailmoitenes were not in the same modular threades what the partial type section is strated by the satchings was 99,5 per cent at 8 95 per cent confidence strated by the satchings was 99,5 per cent at 8 95 per cent of the partial of degree contradering the redundancy of the system (two satchings in 18 2). The organizated that the same confidence in partial 11 the extended that it is severe and the size of the partial for each at 8 95 per cent confidence mat confidence limit. It is recommended that the same the size of the partial